Important Biological Factors for Utilizing Native Plant Species

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Abstract—Native plant species are valuable resources for revegetation of disturbed ecosystems. The success of these plantings is dependent on the native species selected, quality of seed used, condition of the soil, environmental conditions before and after planting, planting equipment used, time of planting, and other factors. Most native species contain dormant seed. Dormancy in domesticated and wild species can make it difficult to establish stands; however, in wild species seed dormancy is one method of perpetuating the species. Temperature, moisture, and light requirements for germination of each species are important factors to know before planting. Each species has an optimum temperature range in which it will germinate. Successful stand establishment begins in the seed production field or collection area with proper nutrient balance, moisture, weed control, time of harvest, seed drying, seed handling, seed conditioning, and storage. Improper harvesting and storage can quickly reduce seed quality. All of these factors must be considered when using native species for revegetation.

Native plant species that are well adapted to the local environment of a particular area generally are more difficult to establish than introduced species. This is especially true of a bunchgrass species like blue grama (*Bouteloua gracilis*), which possesses generally good germination, but poor seedling survival (Hyder and others 1971). Native species such as green needlegrass (*Stipa viridula*) show high dormancy, a survival mechanism, but make stand establishment difficult from seed. The use of grasses appears to offer the best means of stabilization of disturbed lands, but shrub, forb, and legume plantings are desirable to increase vegetative diversity and improve winter grazing value. For shrubs, as with grasses, drought is a deterrent to stand establishment and maintenance. However, native shrubs offer better tolerances to low precipitation environments than introduced shrubs (Bleak and others 1965). In general, native species are the most desirable for reclamation use because of their adaptation to local environments and especially because of their ability to withstand drought, but they are usually the most difficult to establish. Native species are more difficult to establish compared to introduced species due to: (1) mechanical seed quality, (2) presence of seed dormancy, (3) use in mixtures of species, and (4) lack of seedling vigor. In addition to species characteristics, revegetation plantings are usually made on disturbed or poor soils that may contain heavy metals and have high clay contents, and usually are alkaline or acid (Lohmiller and others 1990). The objective of this presentation is to explain why native plants are difficult to establish during revegetation of disturbed lands and that they require the use of proper cultural practice.

Discussion

The selection of appropriate species for use on a particular site is very important, and these species should be selected based on adaptation to the area and future use of the land. In addition, these other requirements should be considered: (1) ability to rapidly establish a stand, (2) ability to reproduce and sustain adequate cover, (3) ability to stabilize the soil to prevent wind and water erosion, and (4) the ability to withstand harsh extremes of the local climate (Lohmiller and others 1990). If the reclaimed area is to be used for grazing, the species should tolerate grazing pressure, fit forage balance, and provide sufficient high quality forage to make grazing the reclaimed land economical. Based on these needs and the need for a diverse plant community, complex mixtures of grasses, shrubs, forbs, and legumes are used.

The use of complex mixtures creates many problems relating to seed biology. For example, selecting the proper planting date and planting equipment is difficult when a complex mixture contains dormant seed species, cool season grasses, warm season grasses, shrubs, and forbs. Spring or fall planting dates are usually chosen to accomodate the majority of the species within a mix. Dormant seed species are best planted in late fall so they will not germinate until the seed has been exposed to a cool moist period to reduce or overcome seed dormancy. However, late fall is not a good time to plant the warm season grasses or the shrubs and forbs. Planting twice may solve the problem—late fall for the dormant species and early spring or late spring for the other species. Even then problems may exist because the cool season species with nondormant seed should be planted in early spring and the warm season species in late spring (Lohmiller and others 1990). Date of planting can be determined by knowing the optimum temperature for germination of each species. Table 1 gives a few examples of optimum temperature for germination testing of seed as recommended by the Rules for Testing Seeds (Association of Official Seed Analysts 1996). Based on these optimum germination temperatures, it is evident that providing the optimum temperature for maximum germination of each species in a mixture is almost impossible. However, by knowing the biological characteristic of the seed and the compatibililty of each species with companion species a more appropriate planting date can be determined (Brown and Wiesner 1984).

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Table 1—Optimum temperatures for laboratory germination of various species.

Plant species	Temperature for germination	Days of germination
	- - °C - -	
Western wheatgrass (*Pascopyrum smithii*)	15-25 dark	28
Sheep fescue (*Festuca ovina*)	15-25 dark	21
Slender wheatgrass (*Elymus trachycaulus*)	20-30 light	14
Blue grama (*Bouteloua gracilis*)	20-30 light	14
Big bluestem (*Andropogon gerardii*)	20-30 light	14
Buffalograss (*Buchloe dactyloides*)	20-35 light	14
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	20-30 dark	28
Skunkbush sumac (*Rhus trilobata*)	20-30 dark	40
Serviceberry (*Amelanchier alnifolia*)	20-30 dark	60

Equipment and Methods

Selection of the proper type of planting equipment is also difficult. It is recommended that the seed be broadcast onto the surface or drill seeded into the disturbed soil. A primary consideration when either broadcasting or drill seeding is depth; small seeds are planted at ¼ inch, medium seed at ½ inch, and large seed at 1 inch (Lohmiller and others 1990). Drill seeding is usually the most successful method of seeding if seeding depth can be controlled. Seeding depth can be controlled for drill seeding by having a very firm seedbed. Use depth bands on the disc openers and packer wheels following the discs (Holzworth and Wiesner 1990). However, if light is required for germination or if you are planting into a soft seedbed, then broadcast seeding is best. If broadcast seeding is used, the seed should be compacted into the soil surface with a corrugated roller to provide good seed-soil contact. Broadcast seeding is used on uniformly rough surfaces and when a large number of species are being planted. Drill seeding is used on seedbeds that are well prepared and when only a few species are used in the mixture (Lohmiller and others 1990). Multiple box drills are availiable and can be used to seed complex mixtures by placing seed with different characteristics into different seed boxes and obtaining more uniform distribution.

Seed Dormancy

Most native species contain dormant seed. There are many definitions of seed dormancy and many different types. A dormancy seed is a viable seed that will not germinate even though it is exposed to the proper environment for germination—proper temperature, moisture, air composition, and light. Dormant seed has a block that will not allow it to germinate until the block has been removed. There are many blocks that are known to prevent germination of dormant seeds (Bewley and Black 1982), such as: (1) immature embryos, (2) impermeable seed coats to water, (3) impermeable seed coats to gases, (4) physical restriction of the seed coat, (5) water soluble inhibitors in the seed coat or fruit, (6) metabolic inhibitors, (7) light sensitivity, and (8) combination of several of these blocks

Dormancy is a means for optimizing the distribution of germination in time or space, and it has great significance in an ecological context (Bewley and Black 1982). Distribution in time can be achieved by spreading germination over an extended period. This happens because seeds of many species show variability in degree of dormancy; the population consequently exhibits sporadic release from dormancy and results in irregular germination. This spreading of germination in time and space is advantageous for perpetuating established plant communities, but creates a problem when trying to re-establish a similar plant community from seed.

Seed Quality

Another factor affecting native species stand establishment is the actual quality of the seed for both purity and germination. Usually native species seed is of poorer quality than seed from introduced species that was harvested from cultivated fields rather than obtained from collections of native stands. Many of the warm season species, such as the grama grasses and the bluestems, have appendages that make them difficult to condition without damaging the seed. A study to evaluate seed quality was conducted using seed collected from plants growing on rangeland and reclaimed spoils in the Colstrip area of southeastern Montana. All seed was collected in the same year from this location. Pure live seed of the native species was less than the seed of species that were readily available in commercial channels (table 2).

Seed Vigor

Seed vigor affects the establishment of native species from seed. Seed vigor is defined in the Association of Official Seed Analysts Seed Vigor Testing Handbook (1983) as "Those properties which determine the potential for rapid, uniform emergence and development of normal seedlings under a wide range of field conditions." Seed vigor is a measure of seed quality that indicates the ability of the seedling to grow rapidly under a wide range of field conditions. Comparative vigor tests were conducted using seed of native and introduced species collected, during the same year, from rangeland and from a reclaimed area near Colstrip, MT. These species were evaluated for vigor using speed of germination and speed of elongation tests. Results are shown in table 3. The average speed of germination index for the introduced species was 15.0 and for the native species 7.1. The average speed of elongation index for introduced species was 6.9 and for native species 4.6. These data suggest that native species are less vigorous and require better soil preparation and environmental conditions for establishment.

Table 2—Pure live seed of species collected from rangeland and from a reclaimed area near Colstrip, MT.

Plant species	Available in commercial channels	Pure live seed
		Percent
Thickspike wheatgrass (*Elymus lanceolatus*)	Yes	82
Western, and slender wheatgrasses (*Pascopyrum smithii* and *Elymus trachycaulus*)	Yes	88
Hard fescue (*Festuca brevipila*)	Yes	88
Switchgrass (*Panicum virgatum*)	Limited	68
Little bluestem (*Andropogon gerardii*)	Limited	67
Green needlegrass (*Stipa viridula*)	Limited	15
Prairie sandreed (*Calamovilfa longifolia*)	Limited	79
Fourwing saltbush (*Atriplex canescens*)	No	13
White prairie clover (*Dalea* sp.)	No	44

Table 3—Seed vigor test results of native and introduced species collected in the same year from rangeland and from a reclaimed area near Colstrip, MT.

Species	Type	Speed of germination index[a]	Speed of elongation index[a]
Crested wheatgrass (*Agropyron cristatum*)	Introduced	11.4b	4.6b
Smooth bromegrass (*Bromus inermis*)	Introduced	18.6a	9.2a
Slender wheatgrass (*Elymus trachycaulus*)	Native	16.3a	8.4a
Bluebunch wheatgrass (*Agropyron spicatum*)	Native	9.3bc	3.4cd
Blue grama (*Bouteloua gracilis*)	Native	1.3d	5.5b
Little bluestem (*Andropogon gerardii*)	Native	.2d	3.9c
Prairie junegrass (*Koeleria cristata*)	Native	8.2c	1.6d

[a]Means in columns followed by letters in common are not significantly different.

Seed Selection

The native species selected for use in a mixture can make a difference in the establishment of the individual species. A study was conducted to evaluate the establishment of seven species when planted in a pure stand, in combination with a wheatgrass base mixture, and in an all species mixture (table 4). All seed in this study was planted based on the number of pure live seed per square meter. The seeding rates for each treatment were as follows: pure stand = 215 pure live seed per m^2, one species with wheatgrass base mixture = 215 pure live seed per m^2, and all species mixture = 86 pure live seed per m^2 of each species, and all 10 species were included in the treatment.

The base mixture species of slender, thickspike, and western wheatgrass were selected because they were excellent native grasses for southeastern Montana, and each species had different establishment characteristics. By using three different treatments we could evaluate establishment of each species with and without competition.

Little bluestem established better with the base mixture than in a pure stand (table 5), but only 3 percent of the pure live seed established in the all species mixture. These data suggest that little bluestem performed well in the base mixture and that competition within the all species mixture was detrimental to its establishment. White prairie clover established well in the all species mixture as compared to other species, but did not compete well with weeds in pure stand (table 5). The poorest stand of white prairie clover was obtained with the base mixture. The base mixture wheatgrass species are well adapted to the area where these studies were conducted, and considering that two are sod-forming grasses and one a bunchgrass, these species at the seeding rate utilized were competitive with white prairie clover.

Fourwing saltbush did not establish well with competition from other species; it did best in pure stand (22 percent of pure live seed established) (table 5). After 3 years, most of the fourwing saltbush was eliminated from the base mixture and all species mixture treatments (unpublished data). Fourwing saltbush in pure stand had 45 percent of the pure live seed emerge, but after 1 year the percentage of pure live seed established was reduced to 22 percent.

Switchgrass established best in pure stand with 11 percent establishment of the pure live seed planted. Competition in the base mixture and the all species mixture reduced the percentage of pure live seed of switchgrass that established in those treatments.

Green needlegrass had good emergence in pure stand and with the base mixture. The pure stand had the same percentage of establishment as emergence (56 percent of the pure live seed). Emergence of green needlegrass in the all species mixture was low. Once the grass plants grew beyond the seedling stage, it was difficult to distinguish between the base mixture species and green needlegrass; therefore, no data was obtained for establishment of green needlegrass in the base mixture and the all species mixture.

Table 4—Species used in the establishment study presented in table 5.

Common name	Abbreviated common name	Scientific name
Little bluestem	LB	(*Andropogon gerardii*)
White prairie clover	WPC	(*Dale*a sp.)
Fourwing saltbush	FWSB	(*Atriplex canescens*)
Switchgrass	SG	(*Panicum virgatum*)
Green needlegrass	GN	(*Stipa viridula*)
Prairie sandreed	PS	(*Calamovilfa longifolia*)
Hard fescue	HF	(*Festuca brevipil*a)
Wheatgrass base mix:		
Slender wheatgrass	BM	(*Elymus trachycaulus*)
Thickspike wheatgrass	BM	(*Elymus lanceolatus*)
Western wheatgrass	BM	(*Pascopyrum smithii*)

Prairie sandreed and hard fescue established similarly in pure stand, base mixture, and all species mixture, indicating that the competition from the other species did not affect their establishment. Prairie sandreed had a higher percentage establishment of pure live seed than did hard fescue (table 5).

The base mixture of slender, thickspike, and western wheatgrass had the highest percentage of pure live seed establishment (30 percent) (table 5). Establishment of base mixture species was generally not affected by the addition of a single species to the mixture; the average percentage of pure live seed that established over all species was 26 percent compared to 30 percent for the base mixture species alone. The addition of one species of either little bluestem, fourwing saltbush, switchgrass, green needlegrass, or prairie sandreed to the base mixture increased percentage establishment over the base mixture alone. The addition of either white prairie clover or hard fescue to the base mixture did not improve percentage of establishment compared to the establishment of the base mixture alone.

The all species mixture (containing 10 species with equal amounts of pure live seed) had only 16 percent of the pure live seed established, and hard fescue was not represented in the established stand. Best stand establishment is usually obtained with simple mixtures that reduce species competition and control weed infestations.

Summary

Native species are difficult to establish due to reduced physiological and mechanical seed quality caused by specific seed characteristics. Most native seed has dormancy that is good for longevity of the species, but makes it difficult to establish a stand. Most native seed has reduced seed vigor, which results in poor seedling growth after germination. Revegetation with native species usually requires the planting of several species together in a mixture. The use of a simple mixture is desirable. Species establishment characteristics should be considered when selecting species to be planted together in a mixture. Most revegetation plantings do not require that a perfect stand be obtained the first or second year after seeding, which allows plants from late germinating seeds an opportunity to establish.

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Table 5—Pure live seed planted in April 1976, the percentage emerged in July 1976 and the percentage established in July 1977.

Common name[a] and treatment	Abbreviated common name[a]	Pure live seed	Number pure live seed per m^2	Pure live seed emerged 1976	Pure live seed established 1977
		Percent		- - - - - - - *Percent*	- - - - - -
Little bluestem pure seed	LB	67.1	215.1	5.9	8.6
Little bluestem with base mix[b]	LB	67.1	215.1	7.1	11.5
	BM	81.7	645.2	32.9	26.2
Little bluestem in all species mix[c]	LB	67.1	86.0	6.9	3.1
White prairie clover pure seed	WPC	44.3	215.1	11.2	8.3
White prairie clover with base mix[b]	WPC	44.3	215.1	5.2	6.5
	BM	81.7	645.2	34.3	21.7
White prairie clover in all species mix[c]	WPC	44.3	86.0	6.9	10.1
Fourwing saltbrush pure seed	FWSB	13.5	215.1	45.9	22.3
Fourwing saltbush with base mix[b]	FWSB	13.5	215.1	45.9	22.3
	BM	81.7	645.2	49.8	31.8
Fourwing saltbush in all species mix[c]	FWSB	13.5	86.0	41.0	4.7
Switchgrass pure seed	SG	67.7	215.1	25.0	11.5
Switchgrass with base mix[b]	SG	67.7	215.1	18.6	8.6
	BM	81.7	645.2	50.8	24.9
Switchgrass in all species mix[c]	SG	67.7	86.0	8.5	5.5
Green needlegrass pure seed	GN	15.3	215.1	56.4	56.1
Green needlegrass with base mix[b]	GN	15.3	215.1	32.5	—[d]
	BM	81.7	645.2	44.5	—[d]
Green needlegrass in all species mix[c]	GN	15.3	86.0	3.1	—[d]
Prairie sandreed pure seed	PS	79.2	215.1	11.2	14.9
Prairie sandreed with base mix[b]	PS	79.2	215.1	2.8	12.7
	BM	81.7	645.2	36.1	25.3
Prairie sandreed in all species mix[c]	PS	79.2	86.0	0.0	14.8
Hard fescue pure seed	HF	87.6	215.1	5.3	5.0
Hard fescue with base mix[b]	HF	87.6	215.1	12.1	3.1
	BM	81.7	645.2	34.6	26.5
Hard fescue in all species mix[c]	HF	87.6	86.0	10.8	0.0
Base mix only	BM	81.7	645.2	47.5	30.4
BM in all species mix[c]	BM	81.7	258.0	43.1	41.6[d]
All species mix	ASM[c]	57.0	860.2	20.3	16.3

[a]Refer to table 4 for complete listing of abbreviated common names and scientific names.
[b]Base mix composed of equal parts pure live seed of thickspike wheatgrass, slender wheatgrass, and western wheatgrass.
[c]All species mix (includes all species in equal pure live seed proportions).
[d]Seedling condition made distinction between green needlegrass and base mix impractical.